RESOURCE DIPLOMACY: THE ROLE OF NATURAL RESOURCES IN INTERNATIONAL POLITICS

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This is the first in a series of reports examining the role of natural resources in international affairs. This first paper presents an overview to the problem discussing historical relationships between resources and politics as well as the meanings and implications of current resource diplomacy patterns. The paper also presents three indicators utilized in the construction of a critical mineral index that identifies critical minerals in terms of their availibility, economic importance, and geographical concentration of reserves.

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Resource Diplomacy:
The Role of Natural Resources in International Politics

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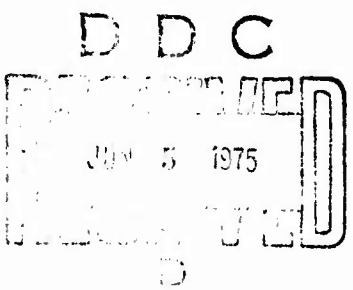

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INTRODUCTION

The study of international affairs is replete with simple characterizations that constitute meaningful references to complex historical situations and processes. The 'cold war', 'detente', the 'third world', 'high politics' -- all are familiar characterizations to students of international affairs. These terms represent a type of historical shorthand whose mention evokes complex and elaborate images of particular personality traits, geographical circumstances, technological factors, etc., attributable to international actors and the 'system' of behavior represented by their interactions. Indeed, these characterizations represent a great deal more than mere images; volume after volume exist to document their specific meaning as historically important episodes.

It now appears that the lexicon of current international politics is being revised and updated to include terms and characterizations befitting the circumstances of the present decade. The wisdom literature of recent note suggests uniformly that "new forces" are at work.(1) One hears reference to new conditions of interdependence, to the utilization of food as a political weapon, and to the replacement of 'gunboat diplomacy' by 'natural resource diplomacy'.(2)

It is interesting to note the increasing frequency and

persistence with which these new terms appear. In large measure this may be attributed to the arousal of public interest in world affairs spurred by contemporary events and global conditions. In recent months the world has experienced the deleterious effects of an oil embargo and the inflation-ridden world economy raises the specter of adverse political consequences for national regimes irrespective of any ideological bearing. Evidence of increased awareness is also seen in the barrage of media reports on the world environmental conference, population conference, food conference, and law of the sea conference. In college and university curricula, new courses have appeared with exotic-sounding titles which bespeak the concerns expressed by the convening of these conferences. Additional evidence of the new concerns is found in the popular and widely circulated periodicals and in scholarly journals. The venerable FOREIGN AFFAIRS has increasingly turned its pages over to discussions of the social and political dilemmas posed by demand and supply factors affecting food, population, and natural resources.

This paper represents the first in a series of reports concerned with the international political implications held by one of these dilemmas. Specifically, the problem is to study the role played by mineral resources in the conduct of international politics. In terms of its more general characteristics, the 1973 oil embargo serves as the major

impetus for this study. The OPEC experience painted a partial portrait of the relationship between one mineral resource and international politics, - the portrait awaits completion with the evaluation of additional minerals contributing substance to the portrait's setting and the specification of additional dimensions to the relationship providing much needed coloration.

Although the study of international relations has not always been susceptible to facile or quaint characterizations, this relationship between minerals and international politics in its most general form is referred to as 'resource diplomacy'. Basically, resource diplomacy may be described as the politico-economic relationship between producer and consumer governments where multi-national corporations often function as intermediaries. The dynamics of the relationship are described by the attempted manipulations of consumers by producers based upon a position of resource strength. To better understand the relationship between minerals and international politics and the dynamics of resource diplomacy itself, the design of this first paper includes both a general discussion of the international political climate of the 1970's and a more specific evaluation of those factors in the distribution and supply of mineral resources assumed to be consequential for the conduct of international affairs.

The paper is divided into two sections. The first section attempts to identify those forces and elements in the contemporary international setting that signal the potential role to be played by mineral resources in international politics. The point was alluded to previously that the patterns of inter-state behavior historically evident, are now emerging with altered content and form. Those factors contributing to the alleged new scene demand consideration. The second section addresses the more specific problem of designating the relevant factors of mineral resources that prompt the concern shown for international politics. If minerals are to play a significant role in shaping the future international order, those factors that contribute to this significance must be identified and evaluated. The discussion therefore, centers around the assessment of numerous political, economic, and technical factors that presage the critical role of mineral resources in international affairs. Subsequent to this, the most salient factors are selected and integrated into an indicator system that examines a number of mineral commodities and identifies those minerals most critical in terms of the contemporary international setting. At the conclusion of the paper, it is hoped that from the 'partial portrait' described above, there will emerge a more richly colored and vividly defined picture of the relationship between mineral wealth and international politics.

Setting the Background: International Politics in the 1970's

A number of writers have examined and commented upon the character of the new forces impacting on international politics. It is therefore hardly surprising to encounter a proliferation of ideas and conceptual schemes designed to order the new phenomena. One of the more compelling schemes has been proposed by Harold and Margaret Sprout. The Sprout's advocate the position they refer to as the "ecological perspective".(3) In large measure, the new forces in international politics may be profitably viewed from this perspective. In their estimation the salient features in the changing context of international politics are viewed as a combination of "the emerging dilemmas of dysfunctional power and grossly insufficient disposable resources, the spreading crisis of priorities, and the inescapable growth of interdependence that is transforming our world into a single ecosystem."(4) The Sprout's concern rests with "identifying and assessing the conditions and trends that will determine the future international order."(5)

Such an assessment is complicated however, by a number of factors. First, is the nearly insurmountable complexity represented by these new forces. The new threats and vulnerabilities to which nations are now subjected are described by a network of interrelated problems across a

variety of technical, social, and political dimensions. Furthermore, there are diverse groups at various levels of social organization that are differentially affected by the new vulnerabilities. Thus, competing interests are at work, where cross-cutting, and often incompatible, lines of authority collide as attempts are made to deal with these complex problems.

A second factor complicating the assessment relates to the 'futures perspective' engendered in the new problems. The time dimension for the demonstration effects is often five, ten, twenty years or more in the future. The time factor is particularly troublesome when viewed from the perspective that sees the human tendency to address the imminent, rather than remote consequences of a problem. Those with visions of the future, who sound the alarm of ecological catastrophe and ruinous social upheaval are often ignored as speculators without data or rebuked for their lack of faith in mankind's inventiveness and ability to overcome adversity. Thus there emerges a continuous debate between the modern day Cassandras and the technological optimists where 'scientific demagoguery' biases insight and distorts evidence to accommodate the exhortations offered by either side.

A more recent interpretation of some of these new forces in the current international setting is offered by Charles McClelland and his Threat Recognition and Analysis

project.(6) In this view, new threat phenomena are seen to be appearing in the international system that are situational in character, viewed as creating large shifts in global relations, and prompting novel patterns of intra-state behavior. In many respects these new threat situations are of a different character than threat conceptualized under the rubric of deterrence. In the new view, three basic differences are apparent.

First, the dynamics of threat have changed. Threat conceptualized from within the deterrence framework was understood as a potential point in time when an aggressor could strike. In the new thinking, threat is described by a sequence of change steps where a situation steadily worsens - the environment deteriorates, minerals are mined out, starvation and famine set in. There is no point at which one can identify when the threat is realized in these new situations; it is a slow and gradual process of change. Second, the identification of parties to the threat may be very difficult under the new conception of threat. This situation precludes the assessment of blame and promotes confusion regarding the locus and nature of a proper response. Historically, threats were unambiguous, the threatened understood who was wielding the threat. In the current view, threat is systemic in nature, not individualistic. The formulation and execution of a response under these conditions is difficult to achieve. A third

distinction is that the emergent threats have little historical precedent. There is no vivid picture to be conjured up to assess the impact if the threat is not controlled. One could surmise that the threat is not believable, or if believable, its effects are not thought to be pervasive. In this regard varying assessments of a threat's manageability have appeared.

In the new view of international politics, these considerations represent unique forces that are distinct from the character of forces historically conceptualized as influencing the conduct of international politics. In the new era, the driving forces of international politics have assumed new forms and the expectations about the future have been clouded over with complex and unconventional factors. National leaders who must deal with these new forms and clouded visions are therefore facing difficult choices as they attempt to influence and anticipate the future. Suddenly, leaders are finding that foreign policy choices now include consideration of the exigencies of natural resource shortages, global pollution, and inadequate food production.

To date, the evidence of national response to the new problems is mixed. A sufficient level of cooperation has been obtained to promote conferences on the international problems of pollution, population, and food, yet cooperation has not been so great as to promote large scale programs and

plans designed to deal with these problems on a world-wide basis. Responses to the oil embargo have ranged from bilateral scramblings to mollify OPEC members, to a conference of oil-importing nations who have agreed, in principle, to collectively share energy resources given future embargoes by the OPEC cartel. The oil embargo is illustrative of the general problem posed by the new forces in international politics. It demonstrated the precarious energy position of the highly industrialized nations and delivered a severe blow to the development plans of those nations representing the Third and Fourth Worlds. More importantly however, the embargo demonstrated the political leverage that may accompany a temporary economic advantage; rarely has dependence displayed a comparable facility for effectuating political turmoil.

It is the OPEC experience that prompts one to ask the question as to where additional instances of such leverage exist. More generally perhaps, one could ask how other resource issues relate to international politics. At least a partial answer may be discerned from the perspective of the international political implications that have been manifest in the past. Historically, minerals have displayed a profound impact on the structure and patterns of the international system as it is recognized today. The diversity in conditions of mineral distributions and production possibilities between different regions of the

world has prompted the appearance of trading blocs seeking advantageous terms of exchange to promote and sustain economic growth. Minerals spawned the mercantile patterns of the 17th and 18th centuries and were largely responsible for the appearance of other variants of economic imperialism.

One example of the intertwining effects of minerals and political factors is seen in the evolution of American involvement in the Middle East. Shortly after World War I American officials initiated the search for additional sources of energy supplies. The war had produced a keen awareness of the strategic importance of an abundant and continuous supply of those resources. Although the United States was in no immediate danger of exhausting its energy reserves, officials realized that additional sources should be secured in order to conserve American reserves and prevent an unacceptable American dependence upon foreign supplies.

In 1920 Congress passed the Minerals Leasing Act that when signed into law established terms of reciprocation whereby foreign corporations chartered in other nations were prohibited from participating in the exploitation of American mineral resources if American corporations were denied similar privileges in those nations. In 1928, with the Minerals Leasing Act establishing official policy, the United States government invited and assisted 6 American oil companies in negotiating what became known as the "Red Line

Agreement" with British Petroleum. This agreement, while acknowledging BP dominance in the Middle East, granted these companies interest rights in Iraq and eventually Bahrain. In a sense, the British were trapped, if they denied the American companies these concessionary rights, British commercial ventures in the United States would be disallowed under the terms of the Minerals Leasing Act.

Following the Red Line Agreement, Standard Oil of California was able to obtain a 60-year concession from Saudi Arabia in 1933. In 1944, Standard Oil, Texaco, and the Saudi Arabian government established the Arab American Oil Company. The history of ARAMCO, as it is known today, serves as a case in point to illustrate the importance of mineral wealth in international politics. During World War II, President Roosevelt provided King Ibn Saud with direct Lend Lease Aid to promote ARAMCO's production and secure it against the threat of a German invasion in the area. The significance of this aid centers on the fact that the material being sent to bolster ARAMCO was done so at the expense of Europe

In addition to Saudi Arabia, another interesting set of circumstances appeared in Iran. In 1943, with State Department approval, Standard Vacuum Company and Sinclair Oil Company obtained an Iranian oil concession. Again, an outside threat appeared, this time however it was the Soviet Union providing the menace. In 1946 the United States,

working ostensibly through the United Nations, thwarted Soviet attempts to establish a sphere of influence in Iran. Once more the strategic importance of the area was illustrated.

By 1953, in little more than 10 years. the American share of production had increased from 14% to 60%. At the same time, the British share had fallen from 81% to 31%.(7) Thus a combination of factors - the war, external threats, a weak Europe, and joint U.S. official/commercial activities- resulted in a strong position in the area. The pattern that evolved demonstrated the extent to which multi-national corporations were instruments of American foreign policy. Moreover, it is this pattern that offers testimony to the saliency of mineral resources in international political affairs.

In the more recent perspective, new issues and problems have been identified that further illustrate how factors in the distribution and supply of minerals may impact on the conduct of international politics. One issue concerns the terms of control over existing resources. Traditionally, control has been conveyed in the standard meanings and implications of sovereignty where nations enjoy the rights and privileges to utilize resources contained within their territorial boundaries. More realistically economic imperialism has seen these ideals compromised. In the new era however, mineral wealth implies the build-up of

diversified markets, securing stable export partners, developing resources at a planned rate while maintaining a controlling interest, and developing manufacturing capabilities. In other words, one may expect to see lesser developed contries driving harder bargains for the development of their mineral resources.

A second dimension of the control issue pertains to the problem of jurisdiction where territorial limits may be vague or in dispute. The controversy over the 200 mile limit extending territorial boundaries to include the continental shelf is a jurisdictional issue. The contention revolves around securing national economic control over the resource wealth found in these waters while ensuring the rights of free passage and navigation. The seizure of fishing boats illustrates the extent to which jurisdiction remains an unresolved and volatile issue.

A second issue, closely related to the terms of control, pertains to the problem of a consumer nation's continued access to the sources of mineral wealth historically utilized to sustain growth and maintain political and economic viability. In its most extreme interpretation, the access issue holds the highest prospect for potential conflict. An example of this potential is illustrated in a scenario constructed by Pirages and Ehrlich in their recent book ARK II: SOCIAL RESPONSE TO ENVIRONMENTAL IMPERATIVES. The authors note the practice in

United States foreign policy of enunciating major policies such as the Monroe and Truman Doctrines. Their scenario is constructed around the expectation that the 1980's may find the U.S. announcing a Doctrine of Implied Supply. This doctrine would state that "a favor thrice conferred becomes an obligation" and those nations that have historically supplied the U.S. with vital fuels and materials must continue to do so or face military consequences.(8) The reasoning stems from the view that since the U.S. depends on certain resources to maintain living standards, denying the necessary resources to sustain those standards constitutes an act of war. Although this scenario may strike the reader as preposterous, Secretary of State Henry Kissinger's now notorious remarks on the possible use of force against OPEC "strangulations" lends a subtle hint of credibility to the Doctrine of Implied Supply.

A less extreme, although equally troublesome, implication of the access issue concerns the employment of secret diplomacy and subterfuge to guarantee access to critical resources. An article by Lord Chalfont in THE TIMES (London, September 30, 1974) argued recently that a nation purchasing at prevailing market prices, those materials vital to the continued well being of its economy has a duty to its citizens to ensure the continued supply of those essential raw materials. The consumer nation is entitled to do something to prevent any regime that might terminate that

supply from coming to power or, at any rate, from remaining in power too long. As the use of force is inconceivable, it has to rely upon secret diplomacy; the use of agents and money in pursuit of that diplomacy is entirely defensible.

A third issue area that illustrates the potential linkage between minerals and international politics concerns the competition for new, unclaimed minerals. The obvious reference here is to the wealth that lies on the ocean floors. The seabed, according to a recent U.N. report is known to contain rich deposits of copper, cobalt, manganese, and nickel. These minerals are in the form of nodules which can be vacuumed from the ocean floor. This unclaimed wealth raises the specter of a ruthless scramble for those natural resources, particularly vexatious is the image of superpower confrontations resulting from the competition over these resources. At the other extreme, those nations of the 3rd and 4th Worlds whose technological capabilities preclude ocean mining, threaten reprisals of an unstated nature should they be excluded from participating in the division of the ocean's wealth. In lieu of an uncontrolled scramble, the U.N. has proposed an international authority that would engage in activities ranging from licensing to the taxation of parties mining the nodules. Whatever the outcome, the scramble for new resources is bound to involve political considerations and in turn affect such considerations.

This discussion illustrates several important points

that provide insight into the general character of the relationship between mineral wealth and international politics. First, one sees a diverse group of international actors involved in the economic and political questions surrounding the use of mineral resources. This group includes multi-national corporations and international organizations as well as nation-states. Second, there are important strategic considerations influencing a nation's evaluation of its resource position. Dependence on a foreign source, whether that source be friend or foe, is an apparent anathema to the image of an independent sovereign state. Third, hegemonial traditions no longer guarantee the persistence of mercantile-type relationships; market forces appear to erode the structure and form of those relationships. Finally, the specter of strife and conflict remains embedded in the scenarios built around the issues of control over mineral wealth.

Each of these issues represents obvious and significant research questions in their own right, but before attempting the search for their answers, one is compelled to consider an important preliminary question. Specifically, one needs to know the degree to which these issues are legitimate concerns for all minerals. There are numerous mineral commodities casually grouped under the heading 'mineral resources', one should not expect profound political implications in each case. The following section addresses

the problem of identifying those minerals for which the above issues are most salient. The basic assumption guiding this identification is that some minerals are described by a unique set of characteristics that engender a potential for political reckoning more than other minerals. Minerals comprising this set are therefore referred to as 'critical'; presenting a systematic procedure for their identification is the task of the following section.

Critical Minerals and Resource Advantage

One approaches understatement in the observation that minerals are an essential component of life in today's world. It is apparent that the mineral resources contained in the earth's crust provide man with the basic elements for sustaining his life and his civilization. Yet embedded in this relationship is a basic dilemma - man is capable of renewal but the minerals needed to sustain him are essentially non-renewable. It is this dilemma that serves as the impetus for the present study. From it emerges the basic insight for the construction of a conceptual linkage between international politics and mineral resources.

One starts from the plausible assumption that raw materials need to be reassessed as to their role in international political relationships. In a technological world where economic sanctions replace military sanctions as a compromise course for a saner existence, the role of raw materials is more critical. Those nations that possess and control such resources are in a stronger position potentially to exert influence over those that depend on their resources, therefore, the reassessment of the role of raw materials in international politics seems an obvious and significant task.

The first problem then is to identify critical minerals. This is not a straightforward task; minerals are

critical for a variety of reasons and from a number of perspectives. At times a mineral may be critical because it is scarce, it may be critical because a nation's economy depends on the revenues from its export. It would be expeditious to state that the present concern rests with identifying those political factors that define a critical mineral but such a declaration ignores the historical insight that sees various economic and technical factors contributing to the political implications of minerals and their role in international politics. In the following paragraphs a number of these economic and technical factors are examined. At the end of the discussion an attempt is made to define critical minerals on the basis of the insight gained from this discussion.

A number of studies have gained international recognition by virtue of their examination of the supply and demand patterns describing various mineral commodities. Although these studies generally agree that the world will eventually exhaust its mineral supply, contention remains as to which minerals are in the most critical supply, the exact time frame of their availability, and the particular social, economic, and political consequences. The Club of Rome study concluded that "the limits to growth on this planet will be reached sometime within the next one hundred years."(9) More recently, the National Security Council sponsored a study that reports:

> The best available data and analysis indicate there are ample materials in the earth's crust to meet the World's needs for nearly every material well beyond the turn of the century.(10)

Although this study did not include energy materials or food, the report noted that the era of scarcity proclaimed by many analyses was the result of high 1973 demands projected into the future. Now however, demand is tapering off and projections need to be revised. Those forecasting shortages are criticized by the report because they do not consider the impact of price factors and other market mechanisms to generate economization, substitution, recycling, improved extraction technology or new discoveries.

The U.S. Bureau of Mines has developed a strategic planning system that incorporates the considerations cited in the NSC's report. The Bureau's mineral availability forecasts indicate that at least 26 mineral commodities are described by cumulative demand patterns (to the year 2000) that exceed the world's supply of recoverable reserves. Although the Bureau specifically warns that their forecasts are essentially "status quo" extrapolations of present trends, the results do provide "warning indicators of the need for managerial action."(11)

Basically, these reports identify a mineral as being

critical when it meets two criteria. First, the mineral must represent an important component of a nation's economy, in other words it must be highly valued for its strategic or technological importance. Second, the mineral must be relatively scarce; demand must exceed reserves. These two criteria define critical minerals at the most general level where the economic forces of the market place are left to adjudge the criticalness of a particular mineral commodity. At a lower level of generalization the possibility of cartelization has been advanced by a number of writers as an additional factor in the identification procedure. In terms of this paper, the prospects for natural resource cartels, similar to OPEC, represents a third criterion for the identification of a critical mineral. The discussion that follows examines the future of resource cartels and attempts to isolate the specific factors in cartel formation that bear upon the identification of critical minerals.

There are a number of reasons for selecting cartelization as a salient variable in the determination of critical minerals. A first reason concerns the apparent desire on the part of many nations to form such cartels. The urge is particularly powerful for those less developed nations whose mineral wealth is as yet untapped and who anticipate the benefits of economic development and modernization from the unclaimed resources. Perhaps more importantly, these same nations have expressed in no

uncertain terms their disappointment and frustration over the treatment they have received at the hands of the industrialized nations of the world. Bension Varon and Kenji Takeuchi, two economists on the Development Policy Staff of the World Bank, summarize these feelings in their observation that "the political urge to form such alliances is there."(12)

In addition to the noted urge to form such cartels, there is additional consensus regarding their future impact. The successful cartelization of certain resources, it is agreed, would manifest a profound impact on the future international order. C. Fred Bergsten has stated that:

> The success or failure of these 'producer's associations' will have a major bearing on world economic conditions, particularly inflation, and on international political relationships for the forseeable future.(13)

Bergsten, a Senior Fellow at the Brookings Institution and noted economist, has written several articles exploring this future. He notes that such commodities as tin, aluminum, coffee, copper, and phosphate, to mention a few, represent major commodities where cartels are trying to be implemented. Bergsten however, represents only one view of the cartel picture. There is by no means a consensus that cartels are destined to appear. Two positions may be identified in the ongoing debate about the success of future

cartels . One position presents evidence to support the argument that OPEC is unique and its success can not be duplicated. The second position argues with equal conviction that "oil is not the exception" and one should expect successful cartels in the future. These two positions are examined in the following paragraphs.

A central theme adopted by the opposition viewpoint in the 'cartel debate' relates to the demonstrated success of OPEC. The "Critical Materials Report" mentioned previously did not envisage the formation of another OPEC-like cartel because no other conditions exist among a group of nations with either the political desire or economic strength of an OPEC. Stephen Krasner, a Harvard Professor writing from the Washington Center of Foreign Policy Research, parrots this position stating that 'oil is the exception.' Krasner points to the failure of previous cartels and notes that:

> Natural scarcities, corporate oligopolies, or commodity agreements between exporting and importing areas may bring higher prices, but no other group of less-developed countries (LDC's) possesses the attributes that permit the oil-rich Arab sheikdoms to independently regulate the world market for a major raw material.(14)

Krasner bases his argument on two specific attributes of the OPEC cartel that sets it apart and accounts for its success. The first distinctive attribute of OPEC is that it possesses enormous foreign exchange reserves that are relied

upon to weather any setbacks in their collusion strategy. There is often a hiatus between a cartel's formation and its control of the market, stockpiles may be utilized by consumers to create an initial resistance and a temporary decline in revenue receipts for the exporting nations. Adequate foreign reserves are needed to cushion the effects of such a resistance. The second distinctive attribute is that OPEC had a common external enemy providing a set of salient, non-economic, shared values for the cartel membership. These shared values, in Krasner's estimation, represent both a stimulus to increase trust among the members and a precaution against defection or cheating.

The defection problem is an important one. Shared values may be necessary to ensure member cooperation in the acceptance of production controls. If production cut-backs are called for as a means for supporting an artificially imposed price, a formula must be agreed upon for prorationing to limit output. If a prorationing formula is to be followed for an extended period of time, nations may have little incentive to conform to the long term strategy requirements; defection from the cartel with a lower price offer might present an attractive alternative for a nation that sees its product utility diminishing over time.

On the opposite side of the debate is C. Fred Bergsten who views a 'new era in world commodity markets'. Bergsten has specifically replied to the position advanced by Krasner

noting that Krasner's examples refuting cartelization belong to a bygone era, shortages of supply have replaced shortages of demand as a dominant force in the world economic market today, and the power position of suppliers and consumers has changed dramatically.(15) More important perhaps, at least in terms of the topic of this paper, is Bergsten's observation that:

> The successes of many developing countries on a variety of fronts, and especially from OPEC itself, have provided them with the skills and courage to effectively promote their own interests.(16)

Bergsten directly challenges the position advanced by Krasner citing four reasons why Krasner's foreign exchange argument fails. First, a number of oil producers are not in a strong foreign reserve position. Iran, Iraq, Algeria, Venezuela, Nigeria, and Indonesia account for 60% of OPEC output but have reserve levels of less than three months. Second, some leaders in other areas of potential cartelships such as Brazil with coffee and Malaysia with tin have diversified economies and an adequate supply of foreign reserves which could carry them through the transition stages of cartel formation. Third, reserve holdings do not indicate the complete picture of a nation's ability to risk failure in a cartelization move. Nations may borrow from international money markets and the possibility for OPEC

financing exists. As Bergsten points out, the Shah of Iran has offered assistance to the Third World in underwriting their efforts to restore favorable terms of trade with OPEC by raising export prices of their export commodities. Fourth, and most important for Bergsten, none of the above "considerations is very important if the likelihood of successful cartelization is high."(17) A monopoly, or even near monopoly in any important commodity is a sufficient condition for successful cartelization.

The 'shared values' argument is also challenged. Bergsten points to the numerous rivalries within the OPEC membership - Iran and Iraq, Iran and Kuwait, Iraq and Kuwait, Iran and Saudi Arabia - to mention a few. Moreover, it strains the imagination to discover the shared values that exist (beyond economic gain) between Nigeria and Venezuela or even between Arab and non-Arab member nations. It should also be noted that while Israel symbolizes "the common external enemy" for some OPEC members, Indonesia, Venezuela, and Nigeria are only tangentially involved in the complex political, social and cultural problems in the beleaguered Middle East.

In Bergsten's view the only political prerequisite appears to be an absence of overt hostility, and this leaves only the common economic gain as the sole explanation for OPEC success. In this regard the potential emulators of OPEC appear in a better position - fewer countries need to

collude, shared values are present, and the economic and technological capabilities for cartelization exist. It is for these reasons and the fact of OPEC's success (and the failure of consumer nation response) that Bergsten views oil as "only the beginning."(18)

There is one final issue in the 'cartel debate' that merits attention, this issue concerns the effects of a long term time horizon on the viability of a cartel. The argument is commonly cited that the chances for a successful cartel are greatly diminished due to the influence of price elasticities over the long term. Such factors as stockpiling, recycling, and the use of substitutes eventually thwart any effort to maintain an artificial price level. In other words , inelasticity may be present over the short term but eventually gives way to elasticity over the long term.

The argument against cartels due to the effects of price elasticity over the long term is not all that persuasive. Recycling, stockpiling and the use of substitutes requires a massive infusion of capital and technology in order to shift the factors of production operating historically. Bergsten further notes that it "is risky to assume that 'the market' will abort cartelization efforts even over the long run" since many factors in the production process are already fixed.(19)

Bergsten's observation could be dismissed as speculative and perhaps should be since the critical counter-argument to the time horizon issue is that it is irrelevant, the real issue concerns the extent to which a resource advantage may be used as a political lever in the short term. Zuhayr Mikdashi, a Professor at the American University in Beirut and advisor to OPEC, has addressed this specific point. Mikdashi acknowledges the real risks in a high price strategy for long run maximization but is quick to recognize the improved chances for success when the strategy for a short term policy change is adopted.(20)

Mikdashi cites the case argued by Harry Johnson for adopting a short term strategy. Johnson's view is that less developed nations should try to maximize their revenues over the short term:

> Given that the less developed countries are anxious to industrialize as rapidly as possible, and in so doing expect to increase the flexibility of their economic structures, it might well be an optimum strategy for them to attempt to maximize their profits from primary production over the short run, at the expense of future earnings, in order to secure their development objectives.(21)

It is precisely this strategy that holds the most important implications for the future of international politics. If a nation, or group of nations, holds a virtual monopoly over the reserves of a scarce and highly valued

mineral commodity, the potential exists for those nations to manipulate the policies of consumers who depend on the supply of that mineral. In this regard, such a mineral commodity should be considered as critical. Large foreign reserves, shared values, the use of substitutes, stockpiling, and recycling all bear upon the long term success of a cartel, but none of these factors are important if nations choose to exercise the prerogatives for manipulation that are implicit in the existence of a short term resource advantage operating in the context of a technologically dependent world.

The implications for this study then are apparent. One needs to know which minerals are relatively scarce, which minerals are economically important, and which minerals are unevenly distributed. In this study a mineral is therefore defined as critical depending upon its position relative to these three general dimensions. The first dimension pertains to the availability of a given mineral - how much exists in relation to how much is used? The second dimension relates to the importance of a mineral in terms of its economic value. The third dimension pertains to the concentration of the supply - how many nations have what percentage of the reserves. The process of operationally defining each of these dimensions is described below.

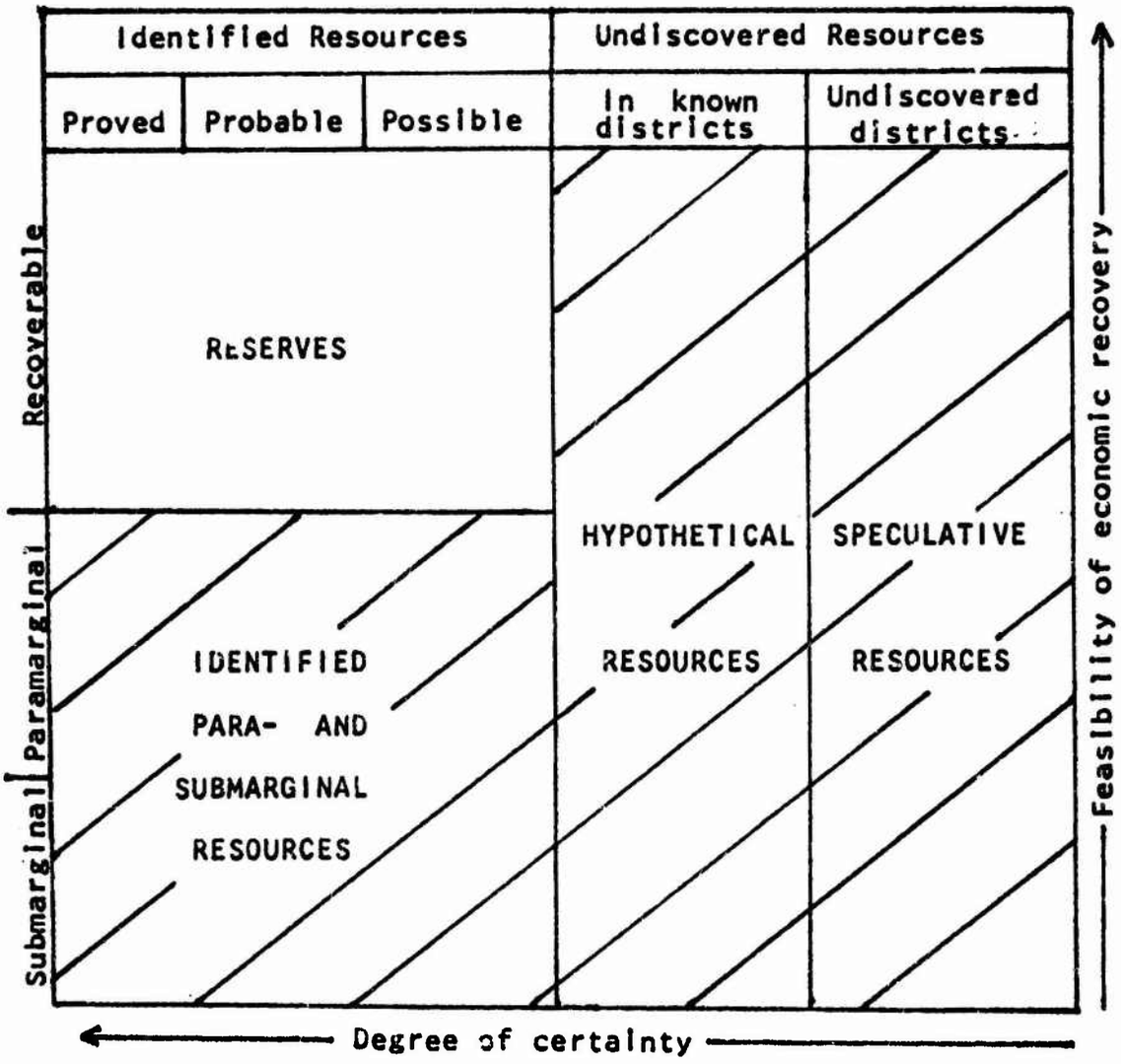
Adequacy

One of the difficulties encountered in assessing the adequacy of mineral supplies is that the term 'nonrenewable resources' is, in its most literal sense, a misnomer. Resources are not a static quantity but rather, they change over time. Consequently the definition of a critical mineral, based solely on supply levels, is less easily achieved than one might expect. Reserve figures vary as a function of production, price factors, substitution, extraction technologies, and new discoveries. Assessing the world's total resources for a given mineral is therefore beset with numerous problems requiring the separation of known deposits from probable deposits, economically recoverable deposits from those deposits from whose recovery is not economically feasible.

In an effort to standardize the procedures for reporting mineral resources, the U.S. Geological Survey utilizes a classification scheme proposed initially by V.E. McKelvey in the AMERICAN SCIENTIST.(22) The rationale for this classification is provided by McKelvey:

> ...in order to differentiate known and presently recoverable resources - that is, reserves - from those that are undiscovered, as well as from those that are known but are not now economically recoverable, a classification must convey two prime elements of information: the degree of certainty about the existence and magnitude of the materials and the economic feasibility of recovering them.(23)

The diagram in figure 1 displays this classification scheme. The degree of certainty is represented on the horizontal scale while feasibility of recovery is represented along the vertical scale. For the purposes of this study, identified, recoverable resources, portrayed in the upper left-hand corner, will be used in the determination of mineral availability. This information provides knowledge as to the amount of reserves in identified deposits where the extraction is economically feasible.



EXPLANATION

Potential resources=Identified + Hypothetical + Speculative

Total resources=Reserves + Potential resources

Resource base=Total resources + other mineral raw materials

Figure 1. Classification of mineral resources being used by the U.S. Geological Survey in assessing total mineral resources in the United States

Recoverable reserves are being utilized for the following reasons. First, they provide the most accurate estimate of mineral availability in the near-term. Although the value of the reserve figures may change over time, their short term accuracy is more reliable as an indicator of a mineral's critical supply. The second reason relates, in part, to the short term accuracy of the reserve figures. In a study such as this where the concern is focused on the political dimensions of mineral resources, the short term advantage is more closely associated with whatever political manueverings may result. Historically, the character of foreign policy or domestic politics is not noted for its long term planning component. A second and perhaps more compelling reason is that a resource advantage is ephemeral, market forces and technology tend to compromise any position of strength over the long term. For these reasons, the reserve figures will be utilized to measure mineral supply.

One also requires information on the consumption or demand patterns for each mineral in order to determine availability. Gathering this information is met with less controversy than that encountered in the resource/reserve debate although it is more difficult since it requires knowledge as to future demand patterns. This necessarily involves forecasting and the extrapolation of trends, - activities which, by their very nature, are less reliable than measurement in the present. Nevertheless, estimates are

made and those that are available represent the combined judgment and knowledge of experts in the fields of geology, economics, and mineralogy. These estimates provide information on the cumulative demand patterns for each mineral commodity through the year 2000. Combining this information with the reserve estimates one may determine the adequacy of supply for any given mineral.

The information displayed in Table 1 represents the aggregate indicator referred to as adequacy. Column 1 provides information as to the amount of known reserves for each mineral. Column 2 displays the estimates for the cumulative demand of each mineral. The ratio of reserves to demand is given in column 3 and represents the indicator value for adequacy. Adequacy is interpreted in the following manner; those minerals with a value LESS than 1.0 represent mineral commodities with an anticipated short supply in the future, i.e., estimated demand is greater than known reserves. Conversely, adequacy values GREATER than 1.0 represent minerals whose supply is sufficient to meet the estimated demand through the end of the century. Twenty-two minerals are described by demand patterns that exceed known reserves with uranium being the most 'inadequate'. The important point however, is that the adequacy indicator is a useful tool for the identification of relatively critical minerals, critical at least in the sense of the information conveyed by supply and demand patterns.

Table 1.[1] Adequacy

Mineral	Reserves[2]	Demand[3]	Adequacy[4]
Aluminum	3577000	1040000	3.44
Antimony	4600	2929	1.57
Barium	107000	109000	.98
Beryllium	420	36	11.67
Bismuth	58	165	.35
Boron	110000	16000	6.88
Bromine	12500	9500	1.32
Cadmium	584	763	.77
Cesium	43	2	21.50
Chromium	132000	96000	1.38
Cobalt	2730	1180	2.31
Columbium	6500	408	15.93
Copper	370000	394000	.94
Flourine	44000	136000	.32
Germanium	2	2	1.00
Gold (5)	1000	1346	.74
Indium (5)	49	75	.65
Iodine	1272	498	2.55
Iron	97000000	19000000	5.11
Lead	96000	144000	.67
Lithium	1640	462	3.55
Manganese	577000	416000	1.39
Mercury (6)	3640	8960	.41
Molybdenum	6000	4500	1.33
Nickel	46000	24000	1.92
Phosphorus	739000	930000	.79
Platinum (5)	357	108	3.31
Potassium	20700000	1000000	20.70
Rare Earth	7700	1113	6.92
Rhenium (7)	1	1	1.00
Rhodium (5)	14	5	2.80
Selenium	120	54	2.22
Silver (5)	5450	16500	.33
Strontium	2730	1937	1.41
Sulfur	1344000	2520000	.53
Tantalum	51	77	.66
Tellurium	37	10	3.70
Thorium	207	63	3.28
Tin	4682	9296	.50
Titanium	165000	97000	1.70

Table 1. (continued)

Mineral	2 Reserves	3 Demand	4 Adequacy
Tungsten	1375	1820	.76
Vanadium	10140	1183	8.57
Yttrium	36	12	3.00
Zinc	131000	249000	.53
Zirconium	10000	9000	1.11
Asbestos	151000	235000	.64
Graphite	10000	23000	.43
Gypsum	2046000	2580000	.79
Kyanite	28000	26000	1.07
Mica Scrap	1400000	10000	14.00
Anthracite	5150000	4518000	1.13
Bituminous (8)	A	107000000	10.00
Natural Gas (9)	1156	2463	.47
Petroleum (10)	667	914	.73
Uranium	350	3334	.10

1. All data in thousand short tons unless otherwise noted.
2. Reserves recoverable at 1972 U.S. prices; Source, "U.S. Bureau of Mines Strategic Planning System" January 1974
3. Cumulative demand 1972-2000; Source, "U.S. Bureau of Mines Strategic Planning System" January 1974
4. Ratio of Reserves to Demand.
5. Data in million troy ounces.
6. Data in thousand flasks - 76 lbs per flask
7. Less than 1 unit for reserves and demand
8. Exact reserves unknown - adequacy assigned 10.00 ratio
9. Data in trillion cubic feet
10. Data in billion barrels

Importance

The second dimension employed in the procedure to identify critical minerals pertains to the relative value or economic importance of a mineral. Economic importance is indicated by the monetary value represented in the current production level for each commodity. The rationale for including this dimension stems from the position that one needs to consider the demand for a mineral in its qualitiative as well as quantitative dimension. Economic importance provides an estimate of the relative impact of a mineral commodity on the world economy. Two minerals may be equally scarce in terms of the adequacy measure, but their economic importance may differ substantially; importance is therefore a useful indicator for the assessment of critical minerals.

The data in Table 2 provide the necessary information for the measurement of economic importance. The data in column 1 represent the level of current production for each mineral phrased in the appropriate production units, e.g., short tons, troy ounces, flasks, etc. Column 2 presents data on the average price per unit of production. The importance indicator is then derived by multiplying the production figures by the price. The values for this indicator are arrayed in column 3. As expected, the energy group represents minerals of greatest value, with the major

industrial metals following.

Before proceeding to the discussion of the third dimension for identifying critical minerals, a word of caution is in order regarding the reliability of the data utilized to construct the importance indicator. The collection of the production figures (Table 2) was beset with a number of problems. First, some minerals have no production figures cited for United States companies due to the proprietary nature of the information. In some cases, U.S. production constitutes a significant proportion of the total world output and therefore it was necessary to estimate a feasible production level. Second, production figures are not always known for all nations and their producing territories, many less developed nations with abundant mineral resources do not always possess the extensive reporting and record-keeping capabilities of the more industrialized nations. Additionally, many centrally planned economies do not always provide accurate records of their production output. A third problem is that production is a multi-phased process, that includes reduction and beneficiation stages. These steps complicate an exact assessment of production output. For example, a general rule in the aluminum industry is that 4 tons of bauxite reduces to 2 tons of alumina that in turn may be reduced to 1 ton of refined aluminum; obviously, this calls for a judicious selection of the appropriate production figure.

The data relating price information has some of the same difficulties as the production figures and for primarily the same reasons. There are numerous price quotations associated with a particular stage of processing for any mineral commodity beginning with the price for mined ore and ending with a price for a refined product. Each stage in the mining process has a value added price that must be eventually considered in the assessment of the economic importance of a mineral. A deliberate attempt was made to report a price figure that represents the economic value of a specific mineral at comparable stages of the mining process between extraction and refining. As an additional precaution, prices were also averaged over a 5-year period from 1970 through 1974 to offset the extreme price oscillations of some minerals.

Despite the problems cited above, the data should represent the best approximations for price and production figures that are publicly available since numerous commodity specialists engaged in the difficult and largely unappreciated task of providing reasonable estimates for each of the minerals included in this study. It is with this background that one should reconsider the utility of the importance indicator. The notion of a resource advantage is a multi-dimensional concept and importance, although a somewhat approximated indicator, represents an important dimension in the determination of any resource advantage.

Table 2. Importance[1]

Mineral	Production[2]	Price[3]	Importance[4]
Aluminum	14070	588.40	8279
Antimony	78.7	2070	163
Barium (e)	3347	28.36	95
Beryllium	.175	128000	22
Bismuth	4.79	11320	54
Boron (e)	2330	75.25	18
Bromine	319	348	111
Cadmium	18.7	6320	118
Cesium	NA	300	NA
Chromium	7300	148	1080
Cobalt	29.6	5460	162
Columbium (e)	.012	4000 (a)	.05
Copper	7940	1072	8512
Flourine	2500	52	130
Germanium	.084	261470	22
Gold (5)	41.17	107	4405
Indium (5)	1.8	2.72	5
Iodine (e)	11.25	3880	44
Iron	982000	73 (a)	71686
Lead	3779	333.20	1259
Lithium (e)	2.47	68	2
Manganese	25000	53.60 (a)	1340
Mercury (6)	262	299	78
Molybdenum	80.25	3680	295
Nickel	757	2920	2210
Phosphorus	12367 (b)	37 (a)	458
Platinum (5)	6.1	154.90	945
Potassium	26745	48 (a)	1283
Rare Earth (e)	8.8	700 (a)	6
Rhenium	.0078	1800000 (a)	14
Rhodium	NA	198 (a)	NA
Selenium (e)	1.24	211.20	1
Silver (5)	299	2.70	807
Strontium	49	61 (a)	3
Sulfur	54.88	23.52	1
Tantalum (e)	.37	15560	6
Tellurium (e)	.20	12960	3
Thorium (e)	1.04	15940 (a)	17
Tin	255.4	4560	1164
Titanium (e)	9	3080	28

Table 2. (continued)

Mineral	2 Production	3 Price		4 Importance
Tungsten	43.9	7560		332
Vanadium (e)	15.15	17800		270
Yttrium	.205	18000	(a)	4
Zinc	6127	425.20		2605
Zirconium (e)	475	65.10		31
Asbestos	4567	111.80		511
Graphite (e)	405	59.50	(a)	24
Gypsum	65743	3.90		256
Kyanite (e)	273	73.00		20
Mica Scrap	230	28.55		7
Anthracite	195100	14.59		2846
Bituminous	3355800	8.90		29866
Natural Gas (7)	46.2	.186	(a)	8593
Petroleum (8)	21.6	4.14		89424
Uranium (e)	24.3	14320		348

1. Source = Commodity Data Summaries, 1975, Bureau of Mines unless otherwise noted
2. Data in thousand short tons unless otherwise noted
3. Price is 5 yr average 1970-74 given in $/short ton
4. Importance data in $ million, production X price
5. Production figure is million troy ounce, price is $/troy ounce
6. Production figure is thousand flasks, price is $/flask
7. Production figure is trillion cubic feet, price is $/thousand cubic feet
8. Production figure is billion barrels, price is average @ wellhead $/barrel

e = estimated world production
NA = not available
a = Source: U.S. Bureau of Mines, "STRATEGIC PLANNING SYSTEM"
b = Source: Minerals, Facts, and Problems 1970

Concentration

The third dimension important to the identification of a critical mineral is described by the distribution of a mineral's reserves. Minerals vary not only in terms of their relative abundance and value but also in terms of their local concentrations. Knowledge concerning specific national reserves for individual mineral commodities provides important information about the potential resource advantage any nation may enjoy relative to the rest of the world. Concentration refers to the number of countries accounting for a given percentage of a mineral's known reserves. The concentration dimension is an important indicator of a critical mineral since it provides basic information regarding the 'market structure' of the mineral's reserves. 'Market structure' in this sense, refers to the structure of 'ownership' - monopolistic, oligopolistic, etc. - information important to understanding who controls the use of a mineral and the extent to which such control is concentrated. The assumption behind the use of this indicator is that the more concentrated a mineral's reserves, the more critical the mineral.

Table 3 displays the information used to measure concentration. The first column of data identifies the country with the largest deposit of reserves for that particular mineral and specifies the amount in percentage

Table 3. Concentration [1]

Mineral	Level 1	Level 2	Level 3	Level 4
Aluminium (Bauxite)	32 AUL	22 GUI	6 JAM	4 GRC
Antimony (b)	50 CHN	10 BOL	12 SAF	12 USR
Barium	40 USA	13 CHN	8 USR	
Beryllium (a)	36 BRA	16 IND	16 USR	
Bismuth	38 JAP	15 AUL	12 USA	10 MEX
Boron	42 USA	25 TUR	19 USR	
Bromine (a)	77 USA	10 FRN		
Cadmium	(see Zinc)			
Cesium (b)	64 CAN	27 RHO	9 SAF	
Chromium	64 SAF	32 RHO		
Cobalt	27 COP	27 AUL	14 ZAM	
Columbium	76 BRA	10 CAN		
Copper	20 USA	16 CHL	9 CAN	6 PER
Flourine(Flourspar)	15 MEX	10 USR	8 TAI	5 USA
Germanium	43 SAF	27 USA	27 COP	
Gold	61 SAF	9 USA		
Indium	22 CAN	20 USA	14 USR	
Iodine (2)	45 CHL	45 JAP		
Iron	15 BRA	12 CAN	10 AUL	6 IND
Lead	36 USA	11 AUL	10 CAN	
Lithium	84 USA	6 CAN	5 USR	5 CHN
Manganese (b)	43 SAF	29 USR	14 GAB	
Mercury	37 SPN	9 YUG	8 USA	7 MEX
Molybdenum	72 USA	16 CHL	9 CAN	
Nickel	30 FRN	16 CAN		
Phosphorus	28 MOR	21 USA	12 SPN	10 AUL
Platinum	64 SAF	32 USR		
Potassium	83 CAN	4 GMW		
Rare Earth	64 USA	12 IND		
Rhenium	49 USA	26 CHL		
Rhodium	(see Platinum)			
Selenium	20 USA	16 CHL	9 CAN	7 PER
Silver	25 USA	13 MEX	11 CAN	10 PER
Strontium	40 CAN	34 MEX	14 SPN	
Sulfur	32 CAN	16 USA	3 JAP	
Tantalum	75 COP	15 NIG		
Tellurium	37 IND	27 USA	15 CAN	
Thorium (3) (b)	44 IND	15 USA	15 USR	12 CAN
Tin	24 INS	12 TAI	10 BOL	8 MAL
Titanium (Rutile)	61 AUL	23 SIE		

Table 3. (continued)

Mineral	Level 1	Level 2	Level 3	Level 4
Tungsten (b)	72 CHN	10 USA	3 KOS	
Vanadium (b)	59 USR	20 SAF	15 AUL	
Yttrium	55 IND	16 AUL	7 BRA	
Zinc	25 CAN	22 USA		
Zirconium (a)	42 AUL	22 USA	11 USR	
Asbestos	42 CAN			
Graphite (2)	45 CEY	45 MAG		
Gypsum	20 CAN	17 USA		
Kyanite	30 USA	20 USR		
Mica Scrap (2)	45 IND	45 BRA		
Anthracite (a)	62 USR	15 CHN	15 USA	
Bituminous	(see Anthracite)			
Natural Gas	29 USR	11 USA		
Petroleum	21 SAU	12 USR	10 KUW	9 IRN
Uranium	28 USA	21 SAF	20 CAN	11 AUL

1. Concentration figures represent % of known reserves
   Source is "Commodity Data Summaries 1975", U.S. Bureau of Mines, unless otherwise noted
   Full country names for 3 letter codes are listed in Appendix 1
2. These percentages are estimates. Exact amount of reserves unknown
3. Thorium reserves for measured amounts

a = Source is U.S. Mining & Minerals Policy, 1973 Appendices
b = Source is Minerals, Facts, and Problems

terms. These data are referred to as the Level 1 concentration. The second column of data identifies the country with the second largest deposit of reserves (Level 2 concentration) and so forth for columns 3 and 4. The minerals are ranked from the most concentrated to least concentrated, on the basos of the Level 1 information, ties are broken by moving to Level 2, Level 3, or Level 4 percentages as needed. The concentration indicator identifies lithium as the mineral whose reserves are most 'concentrated'. The United States enjoys a near monopoly on the ore bodies of lithium with 84% of the world's reserves. At the other extreme, flourine (flourspar) is depicted as the mineral whose reserves are least 'concentrated' with Mexico, Russia, Thailand, and the United States accounting for only 38% of that mineral's reserves.

The data displayed in Tables 1-3 represent all the information required to identify critical minerals. Each mineral has three indicator values associated with it, one indicator assesses the adequacy of a mineral's supply, a second indicator evaluates a mineral's economic importance, and a third indicator describes the relative concentration of a mineral's reserves. By utilizing the information in these tables, one is able to identify which mineral is most 'inadequate', which mineral is most 'important', and which mineral is most 'concentrated'. This leaves the problem of providing an overall assessment whereby a mineral is

evaluated according to its position relative to all three indicators. In other words, what is needed is a "critical mineral index".

One possible method for constructing such an index is to average the three ranks obtained for each mineral on the three indicators. Thus bromine with a rank of 28 on Adequacy, 29 on Importance, and 3 on Concentration would have an overall rank of 20. This procedure was followed but proved unsatisfactory since averaging the ranks sacrificed important information. For example, the large indicator value obtained for the economic importance of petroleum is lost in the averaging procedure. What is needed therefore is a critical mineral index based on a method that preserves the relative weights of each mineral across the three indicators. This may be accomplished through the use of standardized scores.

The data presented in Table 4 represent the standard scores for the mineral data. Standardized scores were calculated for each indicator. These scores are useful for comparing across variables since the values are standardized with respect to a distribution rather than an absolute value. This means that averaging the scores does not result in lost information. On the basis of the standardized scores, as seen in Table 4, the most critical mineral is petroleum whereas the least critical is beryllium.

Table 4

Critical Mineral Index, Standard Score Method

Mineral	Adequacy Score	Importance Score	Concentration Score	Total Score	Final Rank
Aluminum	-.027	.238	-.640	-.429	33
Antimony	.358	-.276	.320	.402	15
Barium	.480	-.281	-.213	-.014	26
Beryllium	-1.722	-.285	-.427	-2.434	53
Bismuth	.610	-.283	-.320	.007	25
Boron	-.735	-.286	-.107	-1.128	48
Bromine	.410	-.280	1.760	1.890	3
Cadmium	.523	-.279	-1.013	-.769	44
cesium (1)	-3.747		1.067	-2.680	55
Chromium	.398	-.218	1.067	1.247	10
Cobalt	.206	-.276	-.907	-.977	46
Columbium	-2.599	-.287	1.707	-1.179	49
Copper	.488	.252	-1.280	-.540	35
Flourine	.616	-.279	-1.547	-1.210	50
Germanium	.476	-.285	-.053	.138	21
Gold	.529	-.008	.907	1.428	8
Indium	.548	-.287	-1.173	-.912	45
Iodine	.157	-.284	.053	-.074	28
Iron	-.371	4.253	-1.547	2.335	2
Lead	.544	-.207	-.427	-.090	29
Lithium	-.049	-.287	2.133	1.797	4
Manganese	.395	-.202	-.053	.140	20
Mercury	.597	-.282	-.373	-.058	27
Molybdenum	.408	-.268	1.493	1.633	7
Nickel	.286	-.147	-.747	-.608	40
Phosphorus	.519	-.258	-.853	-.592	39
Platinum	.0	-.227	1.067	.840	13
Potassium	-3.578	-.206	2.080	-1.704	52
Rare Earth	-.744	-.287	1.067	.036	24
Rhenium	.476	-.286	.267	.457	14
Rhodium (1)	.105		1.067	1.172	11
Selenium	.225	-.287	-1.280	-1.342	51
Silver	.614	-.236	-1.013	-.635	41
Strontium	.391	-.287	-.213	-.109	30
Sulfur	.573	-.287	-.640	-.354	32
Tantalum	.425	-.287	1.653	1.791	5
Tellurium	-.080	-.287	-.373	-.740	43
Thorium	.006	-.286	.0	-.280	31

Table 4. (continued)

Mineral	Adequacy Score	Importance Score	Concentration Score	Total Score	Final Rank
Tin	.579	-.213	-1.067	-.701	42
Titanium	.332	-.285	.906	.953	12
Tungsten	.525	-.266	1.493	1.752	6
Vanadium	-1.083	-.270	.800	-.553	36
Yttrium	.064	-.287	.587	.364	16
Zinc	.573	-.122	-1.013	-.562	37
Zirconium	.453	-.285	-.107	.061	22
Asbestos	.550	-.254	-.107	.189	19
Graphite	.593	-.285	.053	.361	17
Gypsum	.519	-.271	-1.280	-1.032	47
Kyanite	-.461	-.285	-.747	-.571	38
Mica Scrap	-2.202	-.286	.053	-2.435	54
Anthracite	.449	-.107	.960	1.302	9
Bituminous	-1.378	1.605	(See Anthracite)	.227	18
Natural Gas	.585	.257	-.800	.042	23
Petroleum	.531	5.377	-1.227	4.681	1
Uranium	.661	-.265	-.853	-.457	34

1. Scores for cesium and rhodium are approximations since production figures are incomplete

It is interesting to compare the results of the two procedures employed in this identification process. Table 5 displays the 14 most critical minerals identified by the average rank method and the 10 most critical minerals identified by the standard score method. Of particular interest is the relative position of petroleum on these two indices. On the first index petroleum is ranked 14th while on the second, petroleum is ranked 1st. The crucial difference is that the influence of petroleum's economic value is preserved through the use of standardized scores. Averaging the information represented by the ranks ignores the highly valued position of petroleum in today's world, and therfore should be disregarded in favor of the standard score method.

Table 5

Comparing Critical Minerals

Average Rank Method		Standardized Score Method	
Mineral	Average Rank	Mineral	Total Score
Gold	12.67	Petroleum	4.681
Tungsten	15.00	** Iron	2.335
Anthracite	16.00	Bromine	1.890
* Natural Gas	17.00	** Lithium	1.797
Chromium	17.67	Tantalum	1.791
Molybdenum	19.00	Tungsten	1.752
* Asbestos	19.00	Molybdenum	1.633
Bromine	20.00	Gold	1.428
* Lead	20.67	Anthracite	1.302
* Zinc	20.67	Chromium	1.247
* Uranium	20.67	** Titanium	.953
Tantalum	21.00		
* Graphite	21.00		
Petroleum	21.67		

* Indicates minerals critical only on Average Rank Method

** Indicates minerals critical only on Average Score Method

The exercise is now complete. A critical mineral index has been constructed enabling one to identify minerals whose economic and technical characteristics signal a resource advantage that may be potentially utilized as a policy lever. As seen in Table 5, petroleum, iron, bromine, lithium, tantalum, tungsten, etc., represent those minerals where this potential is the greatest. It is for this reason that those minerals are designated as critical. Others may propose alternate schemes for the construction of a critical mineral index, assigning greater weights to any of the three indicators utilized above or including additional indicators according to their reading of the potential impact of mineral resources on international politics. The point however, is that the procedure is visible, one may adjust it to accommodate a particular insight but at least the implications of that insight will be known to those examining the results.

In conclusion, this paper has set the stage for the more important analyses that are to follow in succeeding reports. The critical minerals identified in this paper need to be examined further. One needs to understand for whom the consequences of these minerals being critical are the greatest. This requires more detailed information regarding the dependency relationships described by the end use patterns of the critical minerals and how those patterns

change in the give and take of inter-state dealings. Despite this remaining work, the identification of critical minerals accomplished in this paper constitutes an important first step in the investigation of any potential role resource diplomacy may play in the future of international politics.

Footnotes

(1) The reference here is to Seyom Brown's NEW FORCES IN WORLD POLITICS, (Washington,D.C.: Brookings Institution, 1974).

(2) The term 'resource diplomacy' is attributed to the government of Australian Prime Minister Gough Whitlam. See Takashi Oka, "Resources Diplomacy," CHRISTIAN SCIENCE MONITOR, June 21, 1974, p. 1.

(3) See Harold Sprout and Margaret Sprout, THE ECOLOGICAL PERSPECTIVE ON HUMAN AFFAIRS, WITH SPECIAL REFERENCE TO INTERNATIONAL POLITICS, (Princeton: Princeton University Press, 1965).

(4) Harold Sprout and Margaret Sprout, TOWARD A POLITICS OF THE PLANET EARTH, (New York: Van Nostrand Reinhold Company, 1971), p. 11.

(5) Ibid.

(6) The "Threat Recognition and Analysis" Project is located at the International Relations Research Institute of the University of Southern California.

(7) For a concise statement of American involvement in the Middle East see Robert J. Donovan's feature length article, "How U.S. Role Grew in Mideast," LOS ANGELES TIMES, Febuary 9, 1975, "Opinion" section, p. 1.

(8) Dennis C. Pirages and Paul R. Ehrlich, ARK II: SOCIAL RESPONSE TO ENVIRONMENTAL IMPERATIVES, (New York: The Viking Press, 1974), p. 233.

(9) Donella H. Meadows, et. al., THE LIMITS TO GROWTH, (New York: Universe Books, 1972), p. 23.

(10) "No Lack of Raw Materials," U.S. NEWS & WORLD REPORT, December 9, 1974, p. 96.

(11) "U.S. Bureau of Mines Strategic Planning System," Bureau of Mines, January 1974 (mimeo).

(12) Bension Varon and Kenji Takeuchi, "Developing Countries and Non-Fuel Minerals," FOREIGN AFFAIRS, 52, 3 (April 1974), 505.

(13) C. Fred Bergsten, "The New Era in World Commodity Markets," CHALLENGE, Brookings Institution, September - October 1974, p. 34.

(14) Stephen D. Krasner, "Oil is the Exception," FOREIGN POLICY, 14 (Spring 1974) 68.

(15) C. Fred Bergsten, "The Threat is Red," FOREIGN POLICY, 14(Spring 1974) 85.

(16) Ibid., p. 86.

(17) Ibid.

(18) Ibid., p. 90.

(19) Bergsten, "The New Era...," p. 34.

(20) Zuhayr Mikdashi, "Collusion Could Work," FOREIGN POLICY, 14(Spring 1974), 61

(21) Ibid., also Harry G. Johnson, ECONOMIC POLICIES TOWARD LESS DEVELOPED COUNTRIES, (Washington: Brookings Institution, 1967), p. 155.

(22) see V.E. McKelvey, "Mineral Resource Estimates and Public Policy," AMERICAN SCIENTIST, 60(1972),32-40.

(23) Vincent E. McKelvey, "Mineral Potential of the United States," in MINERAL POSITION OF THE UNITED STATES, ed. by Eugene N. Cameron (Madison: University of Wisconsin Press, 1973), p. 70.

Appendix 1.

USA	United States
CAN	Canada
CUB	Cuba
HAI	Haiti
DOM	Dominican Republic
JAM	Jamaica
TRI	Trinidad-Tobago
BAR	Barbados
MEX	Mexico
GUA	Guatemala
HON	Honduras
ELS	El Salvador
NIC	Nicaragua
COS	Costa Rica
PAN	Panama
COL	Columbia
VEN	Venezuela
GUY	Guyana
ECU	Ecuador
PER	Peru
BRA	Brazil
BOL	Bolivia
PAR	Paraguay
CHL	Chile
Arg	Argentina
URU	Uruguay
AFP	Alliance for Progress
OAS	Organization of American States
UNK	United Kingdom
IRE	Ireland
NTH	Netherlands
BEL	Belgium
LUX	Luxemburg
FRN	France
MOC	Monaco
LIC	Liechtenstein
SWZ	Switzerland
SPN	Spain
AND	Andorra
POR	Portugal
GMW	Germany/Fed. Rep.
GME	Germany/Dem. Rep.
POL	Poland

AUS	Austria
HUN	Hungary
CZE	Czechoslovakia
ITA	Italy
VAT	Vatican
SAN	San Marino
MLT	Malta
ALB	Albania
YUG	Yugoslavia
GRC	Greece
CYP	Cyprus
BUL	Bulgaria
RUM	Rumania
USR	USSR
FIN	Finland
SWD	Sweden
NOR	Norway
DEN	Denmark
WAR	Warsaw Pact
ICE	Iceland
NAT	NATO
EEC	EEC
EFT	EFTA
UNO	United Nations
GAM	Gambia
MLI	Mali
SEN	Senegal
DAH	Dahomey
MAU	Mauritania
NIR	Niger
IVO	Ivory Coast
GUI	Guinea
UPP	Upper Volta
GUE	Equitorial Guinea
GBI	Guinea-Bissau
LBR	Liberia
SIE	Sierra Leone
GHA	Ghana
TOG	Togo
CAO	Cameroun
NIG	Nigeria
BIA	Biafra
GAB	Gabon
CEN	Central African Republic
CHA	Chad
CON	Congo/Brazzaville

Appendix 1. (continued)

COP	Zaire/Kinshasa
UGA	Uganda
KEN	Kenya
TAZ	Tanzania
BUI	Burundi
RWA	Rwanda
SOM	Somalia
ETH	Ethiopia
ZAM	Zambia
RHO	Rhodesia
MAW	Malawi
SAF	South Africa
ANG	Angola
LES	Lesotho
BOT	Botswana
SWA	Swaziland
MAG	Malagasy
MAR	Mauritius
OAU	Org. of Afr. Unity
MOR	Morocco
ALG	Algeria
TUN	Tunisia
LBY	Libya
SUD	Sudan
IRN	Iran
TUR	Turkey
KUR	Kurdistan
IRQ	Iraq
UAR	Egypt
SYR	Syria
LEB	Lebanon
JOR	Jordan
ISR	Israel
SAU	Saudi Arabia
UAE	United Arab Emirates
YEM	Yemen
SYE	South Yemen
KUW	Kuwait
BAH	Bahrain
QAT	Qatar
MOM	Muscat and Oman
ARL	Arab League
AFG	Afghanistan
CHN	China/ People's Rep
MON	Mongolia
CHT	China/ Taiwan
HOK	Hong Kong
MAC	Macao
KON	Korea/North
KOS	Korea/South
JAP	Japan
IND	India
BHU	Bhutan
BGD	Bangladesh
PAK	Pakistan
BUR	Burma
CEY	Sri Lanka/Ceylon
MAD	Maldive
NEP	Nepal
TAI	Thailand
CAM	Cambodia
LAO	Laos
VTN	Vietnam/North
VTS	Vietnam/South
MAL	Malaysia
SIN	Singapore
PHI	Philippines
INS	Indonesia
AUL	Australia
NEW	New Zealand
NAU	Nauru
FIJ	Fiji
WSM	Western Samoa